Development of Improved Methods for Propagation of Hybrid Hazelnuts from Hardwood Stem Cuttings in Low-Cost Humidity Tents

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American hazelnuts are disease resistant and winter hardy in the Upper Midwest.

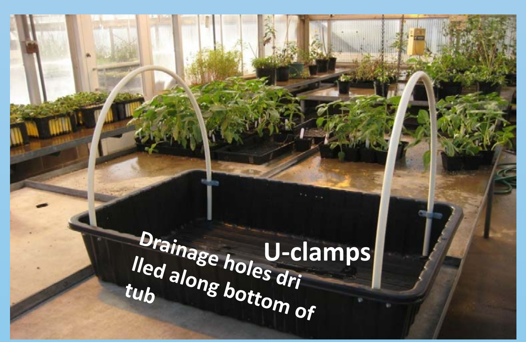
European hazelnuts produce larger nuts which shell out easily.

Hybrid hazelnuts are being bred to combine the best of both.

Introduction

Hybrid hazelnuts (*Corylus avellana x Corylus americana*) are a potential new woody perennial crop for the Upper Midwest being developed for their ecological and economic value. Breeding improved varieties is the first priority of our program, but developing economically viable propagation methods is an essential part of that because genetically uniform plant materials are needed for well-replicated germplasm and agronomic trials, and also for eventual wide-scale adoption of improved varieties. Grafting hybrid hazelnuts doesn't work because they are multi-stemmed; layering cannot produce the large numbers of clones needed; and micropropagation is currently too expensive to do many breeding lines. Hardwood stem cuttings are a low-cost alternative.

Methods for All Experiments



Humidity tent made of a plastic tub with arches made of two 5-foot PVC pipes.

Dormant first year crown suckers (suckers to emerge from the crown of the mother plant after coppicing) were collected in the fall. Stems were cut into segments and the basal ends of the segments were dipped in 2,000 mg L-1 IBA (Indole butyric acid) dissolved in 50% ethanol for about 10 sec. and then inserted in a 1:3 mixture of peat and perlite in humidity tents placed in a greenhouse. The tents were covered with white 70% shade plastic and sealed at the sides to maintain relative humidity near 100%. After two months, stems were pulled to evaluate rooting. Stems that had died were discarded, stems that were rooted were potted, and stems that were not were returned to the tent to be evaluated again a month later. This was repeated until all stems had either rooted or died, about five months after the start of the experiments.

A finished humidity tent with the plastic sealed at the sides and ends with 2 inch paper clamps.

Experiment 1: Finding the Ideal Stem and Stem Segment Size

Methods. Stem length and basal caliper were measured, then stems were sorted into groups of similar size. Within each group one stem was cut into five segments, another into four, then three and two, with one being left uncut (unless too long to fit in the tent uncut).

Results.

- Rooting % was negatively correlated with stem diameter at p = 0.0002. That is, thin stems rooted better than thick stems.
- The highest rooting % was attained with uncut stems, of which 69% formed roots.
- Basal, medial and terminal segments rooted equally well.
- Rooting percent increased linearly with increasing segment length at p = 0.0003, but decreased linearly with increasing segment caliper at $p < 0.05$.

Discussion and Conclusions. The inverse relationship between rooting ability and stem diameter is likely due to increased sclerenchymatous fiber or increased suberization of the cortex in larger and older stems, which present a physical barrier to emergence of adventitious roots (Schwartz et al. 1999). The positive correlation between rooting and segment length is likely to be simply a function of increased carbohydrate stores in longer cuttings (Veierskov,1988). Because of the trade-off between the inhibition of root emergence in stems with a thick cortex and the contribution of carbohydrate stores to root development in larger stems, we concluded that the size to select for cuttings is whatever the mother plant provides. In other words, use them all! Cutting stems into smaller segments to get more propagules is counterproductive, probably because it reduces carbohydrate stores. Future research into methods of inhibiting suberization of stems as they grow larger may yield better success with rooting hardwood stem cuttings.

Some cuttings 3 ½ months after being started, about to be evaluated. Some have healthy leaves and have likely formed roots while others are dead and should be discarded.

Experiment 2: Managing Temperature and Humidity with Humidifiers.

Rationale and methods. Sealed humidity tents tend to build up heat to stressful levels, up to 50ºC, so humidifiers were tested with unsealed plastic ("vented" tents) to see if they could maintain high humidity while keeping temperatures low. Rooting in three vented tents with humidifiers was compared with rooting in three sealed tents. If the relative humidity in a tent fell below a threshold of 60% it was hand watered.

Results.

- Both air and rooting medium temperatures were consistently lower in the vented tents than in the sealed tents.
- Relative humidity dipped to 28% in the vented tents, even though they were watered 22 more times than the sealed tents over the five month course of the experiment.
- Stem mortality in the first two months was significantly higher in the sealed tents than in the vented tents: 78% versus 53%.
- Significantly <u>fewer</u> rooted cuttings were produced in the sealed tents than in the vented tents (15% vs 32%, p < 0.001), probably because fewer cuttings survived long enough to form roots in the sealed tents.

Experiment 2 continued: Managing Temperature and Humidity

Discussion. Because heat and humidity were highly correlated, we cannot say whether the higher mortality in the sealed tents was due to high heat or high humidity. However, in this experiment we learned that stem cuttings can tolerate much lower humidity than previously thought and still survive long enough to form roots. LeBude et al. (2004) found that low humidity may actually stimulate rooting in loblolly pines, so the same may be true for hazelnuts.

Summary and Conclusions. Maintaining tents at nearly 100% is not necessary and may be counterproductive. Open tents that allow for ventilation and prevent overheating are better. Hazelnut stem cuttings can tolerate humidity as low as 28%. Humidity can be maintained without sealing the tents and without humidifiers (which can be challenging to maintain) simply with routine watering.

Experiment 3: Date of start of rooting.

Rationale. Some species of plants never go into dormancy if they are not subjected to the conditions that trigger dormancy, such as reduced daylength or reduced temperature, as we have observed with some potted hybrid hazelnuts in our greenhouse. We hypothesized that by collecting stems before full dormancy we might harness the natural process of translocation of carbohydrates from leaves into roots during autumn senescence to enhance adventitious root formation. We also wished to test how much vernalization of dormant stems was needed before rooting.

A well-rooted cutting. Healthy rooting was usually correlated with healthy leaves.

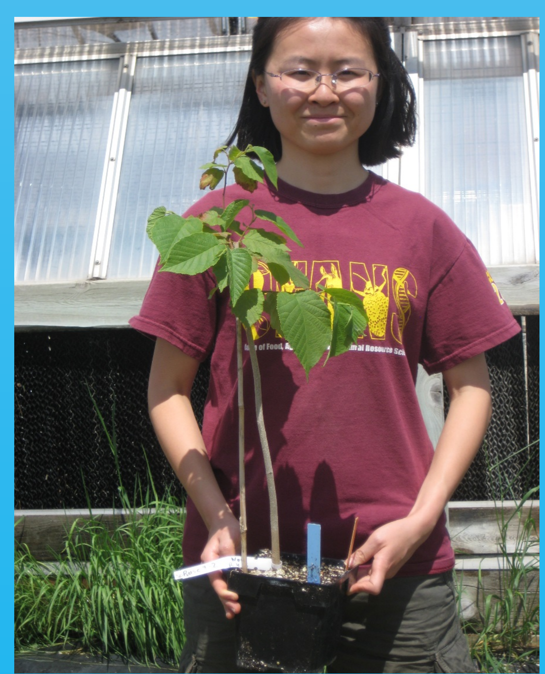
Methods. Stems were collected from source plants on Sept. 25 and Oct. 18, when they were still in full leaf, and on Nov. 3, soon after leaf abscission. Stems collected in full leaf were prepared for rooting the next day (with leaves either intact, cut in half, or completely removed), whereas leafless stems collected in Nov. were stored for three later start dates: Nov. 26, Dec. 19, and Jan. 22 (23, 46 and 80 days after collection).

Results.

- Cuttings collected in full leaf all dropped their leaves and died, regardless of leaf removal treatment.
- For cuttings collected after leaf drop, there were no significant differences in rooting %, or root quality, or production of viable rooted plants between those started in Nov., Dec., or Jan.
- The longer the stems were vernalized, the faster they broke bud after being placed in the humidity tents and the faster they produced roots.

Discussion and Conclusions. By Sept. 25 induction of dormancy had already been set in motion and appeared to be irreversible except by vernalization. However, for stems collected after leaf abscission, the period of vernalization required was much less than previously assumed, only 23 days of controlled chilling in addition to whatever hours had already accrued in the field by Nov. 3. By starting stems earlier we were able to avoid the need to manage over-heating in the greenhouse in the late spring, and to get plants outside, where they are easier to manage, earlier.

Overall Conclusions



An exceptionally good looking rooted cutting which was up-potted to a larger pot in mid-summer. We wish they all looked this good!

In spite of the improvements identified by these trials, overall only about 35% of hardwood stem cuttings formed roots, of which about 85% to survived, for an overall productivity of 30%. Unless future trials identify new ways to improve the method, propagation from hardwood stem cuttings will not be productive enough to supply the large numbers of plants needed by growers. However, the method is still useful for providing the small numbers of clones needed for a breeding program and for agronomic trials in situations where mound layering is not feasible.

Literature Cited

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